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**MacCall et al.**

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(54) **SYSTEM, METHOD, AND COMPUTER PROGRAM PRODUCT FOR MANAGING ACCESS TO AND NAVIGATION THROUGH LARGE-SCALE INFORMATION SPACES**

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(52) **U.S. Cl.** ..... **707/100; 707/9; 707/10; 709/225**

(58) **Field of Search** ..... 707/1, 10, 100, 707/104.1, 2, 3, 4, 9, 201; 709/203, 328, 223, 224, 225, 226; 345/853, 855

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(57) **ABSTRACT**

A system, method and computer program product for managing access to and navigating through large-scale information spaces. A digital library is created by maintaining an ontological hierarchy in a database. Content is accessible through links to resources available over a communications network, such as the Internet. Librarians tailor the accessibility of content of the library as well as the view into the library that is presented to their user population to meet the specialized needs of their users. Content available via the library may be privileged according to qualitative feedback from users maintained within the digital library. An exact-server log tracks the traversal of users through the digital library. The functionality of the digital library is accessible via an application program interface.

**36 Claims, 10 Drawing Sheets**

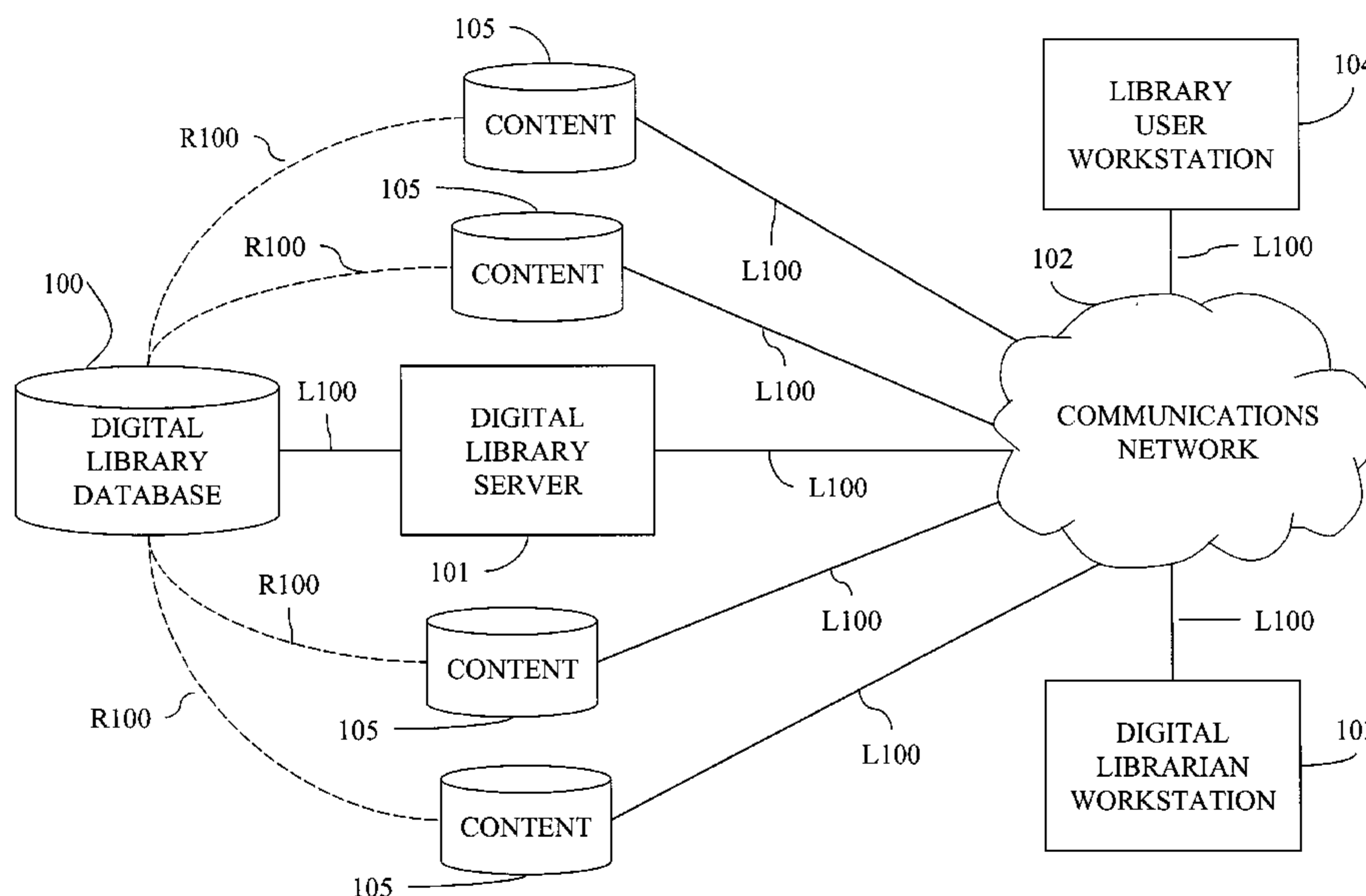


FIGURE 1

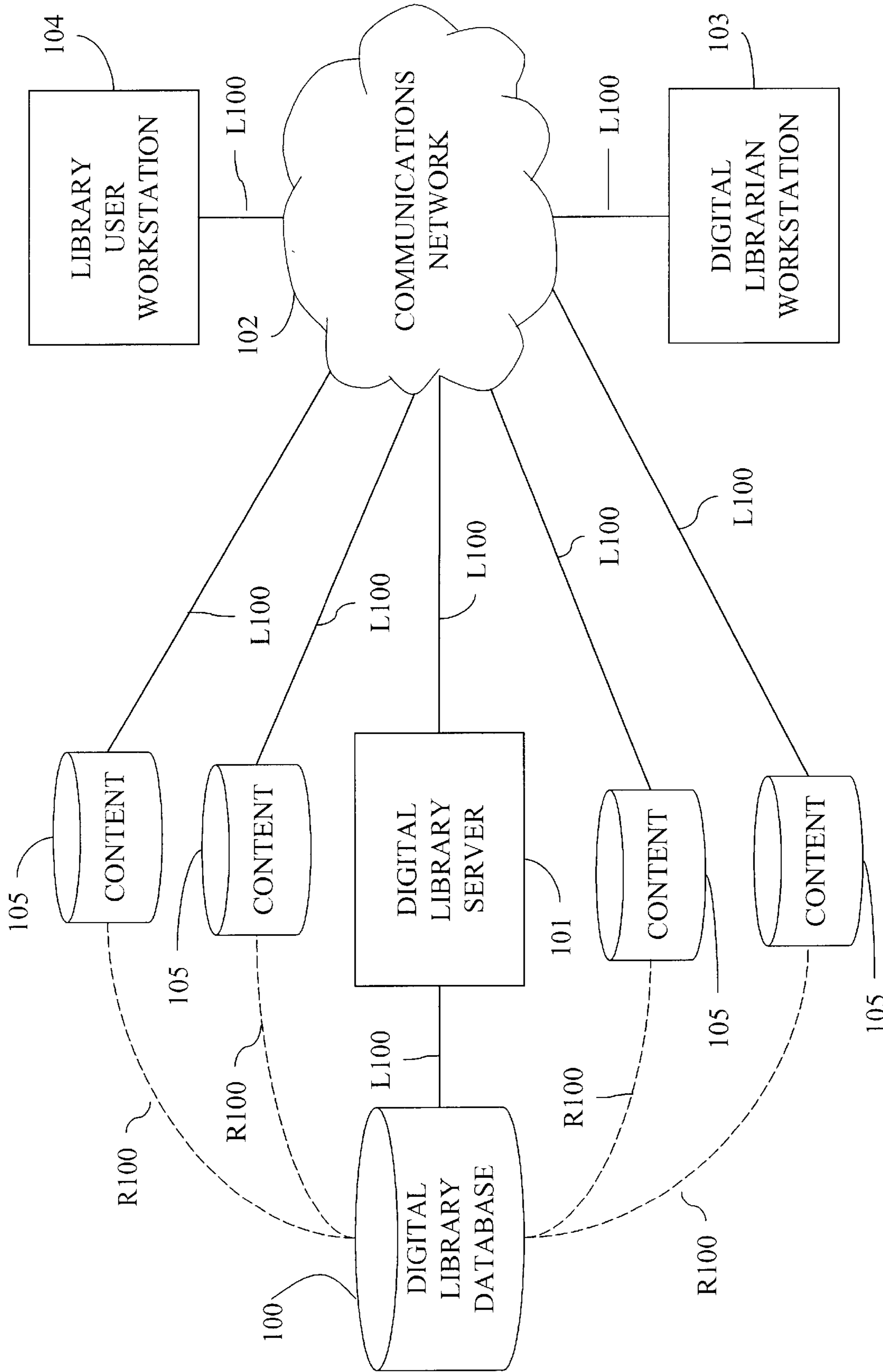


FIGURE 2

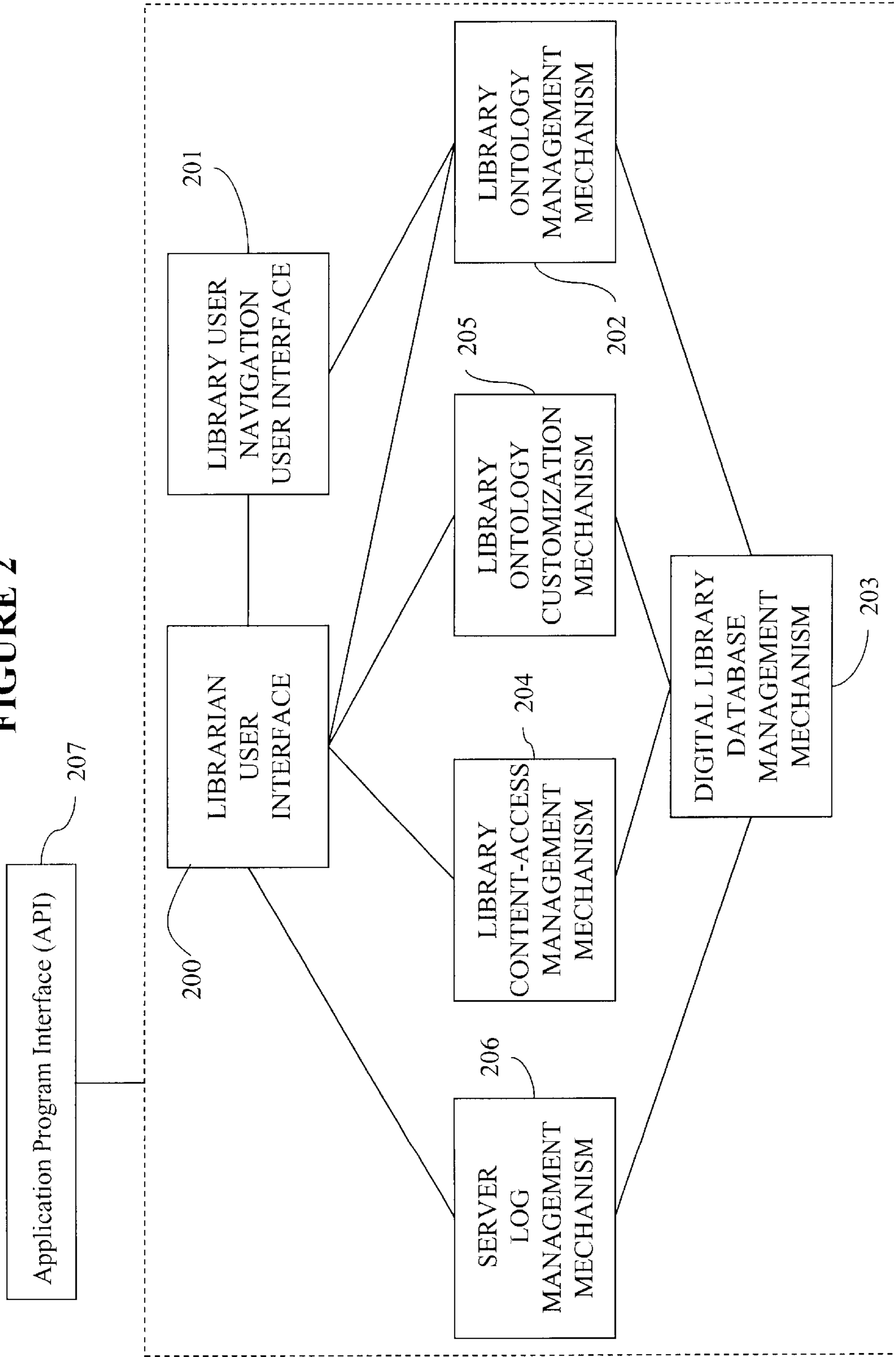
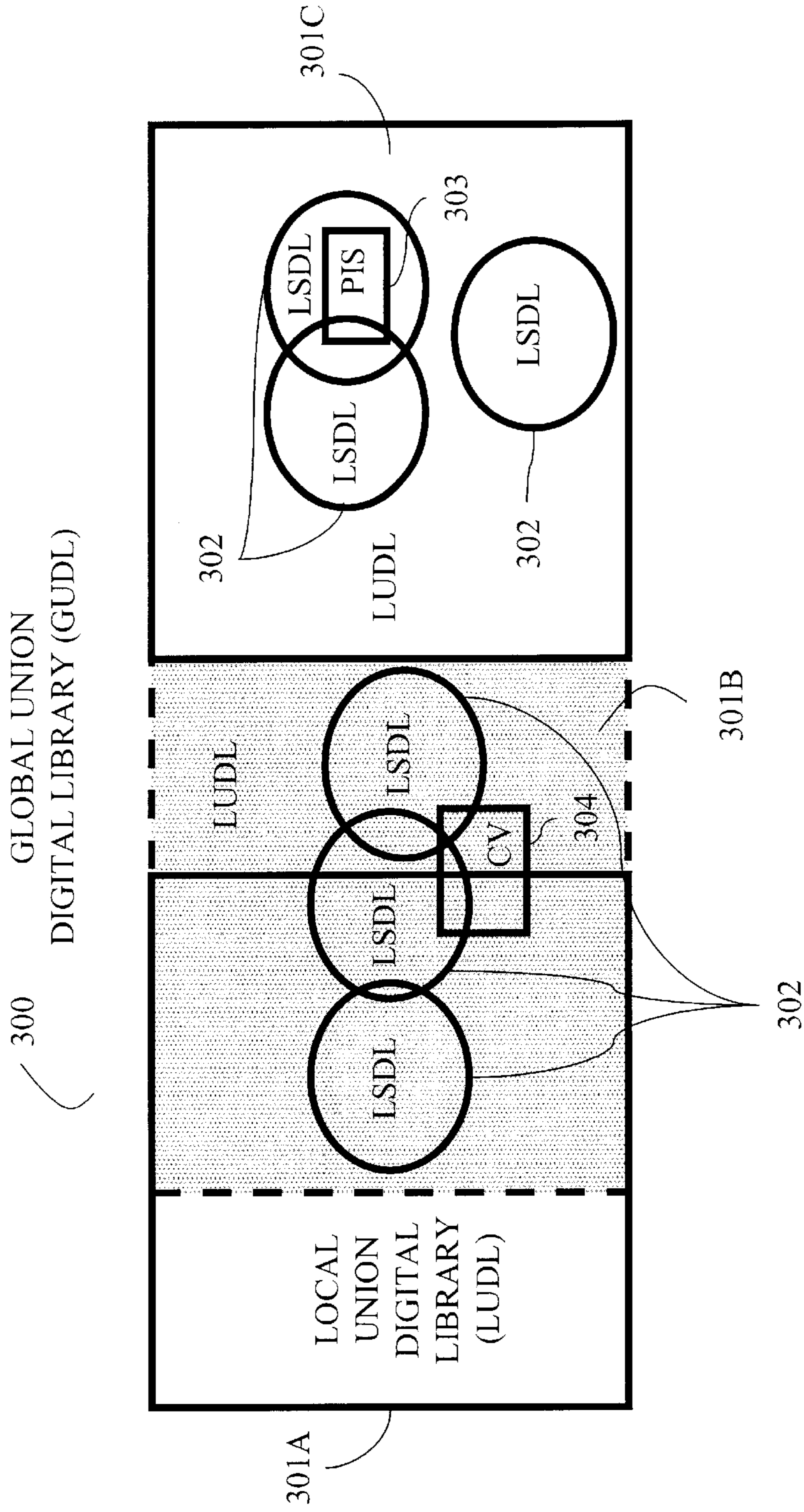


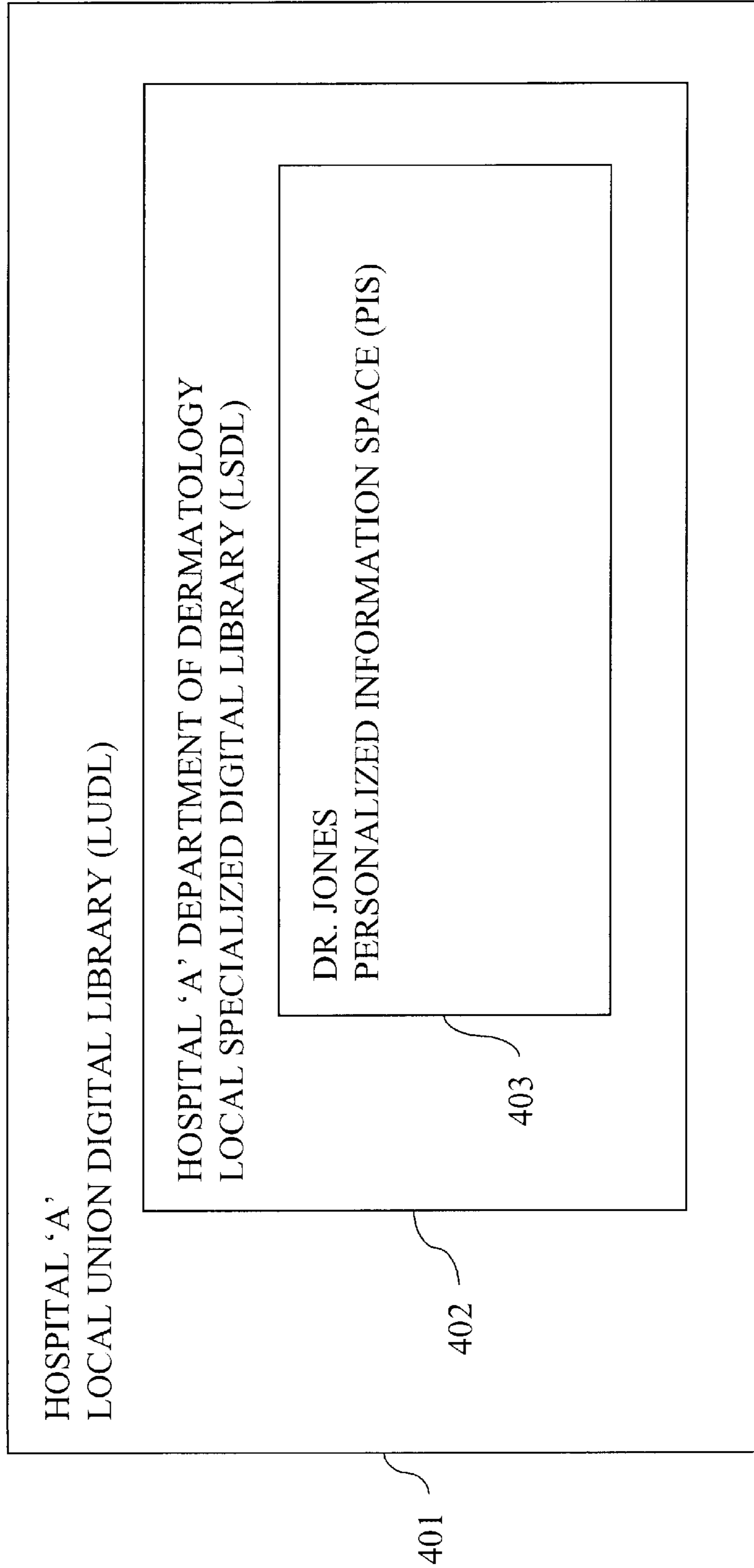


FIGURE 3



LUDL = LOCAL UNION DIGITAL LIBRARY  
 LSDL = LOCAL SPECIALIZED DIGITAL LIBRARY  
 PIS = PERSONAL INFORMATION SPACE  
 CV = COLLEGIAL VIEW

FIGURE 4



**FIGURE 5**

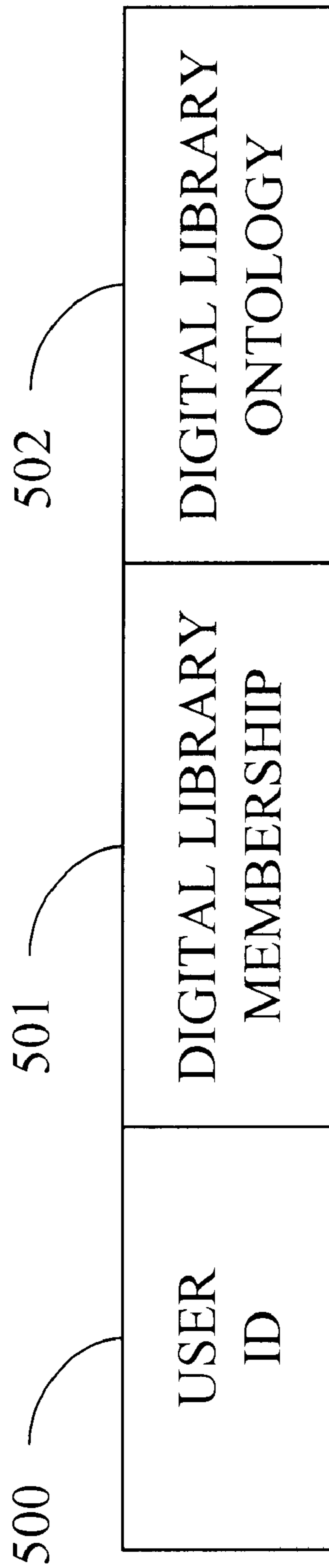


FIGURE 6

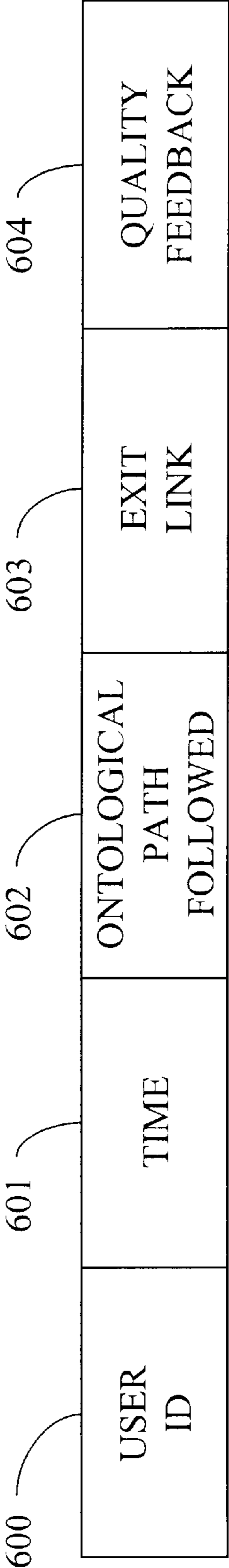


FIGURE 7

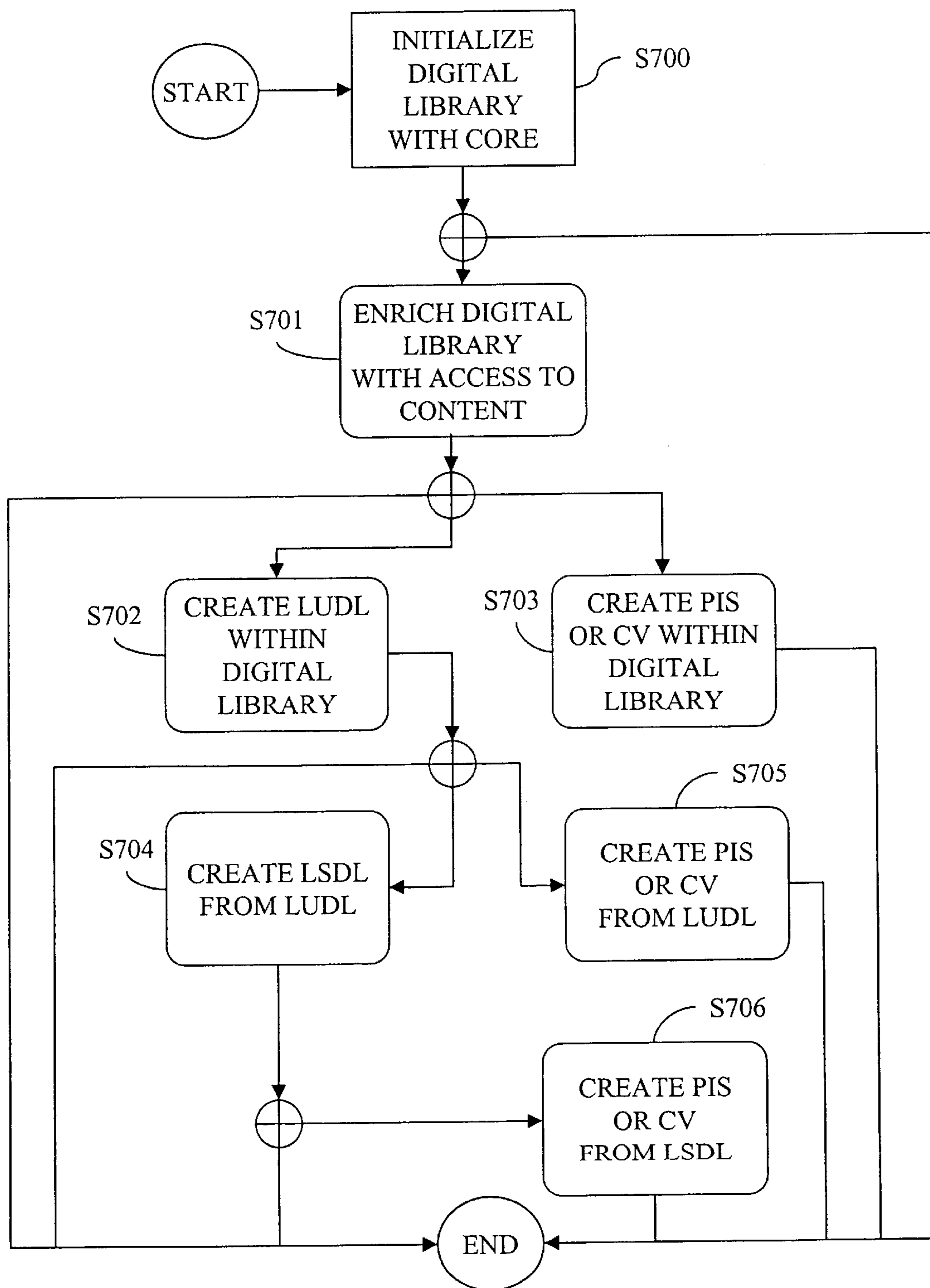
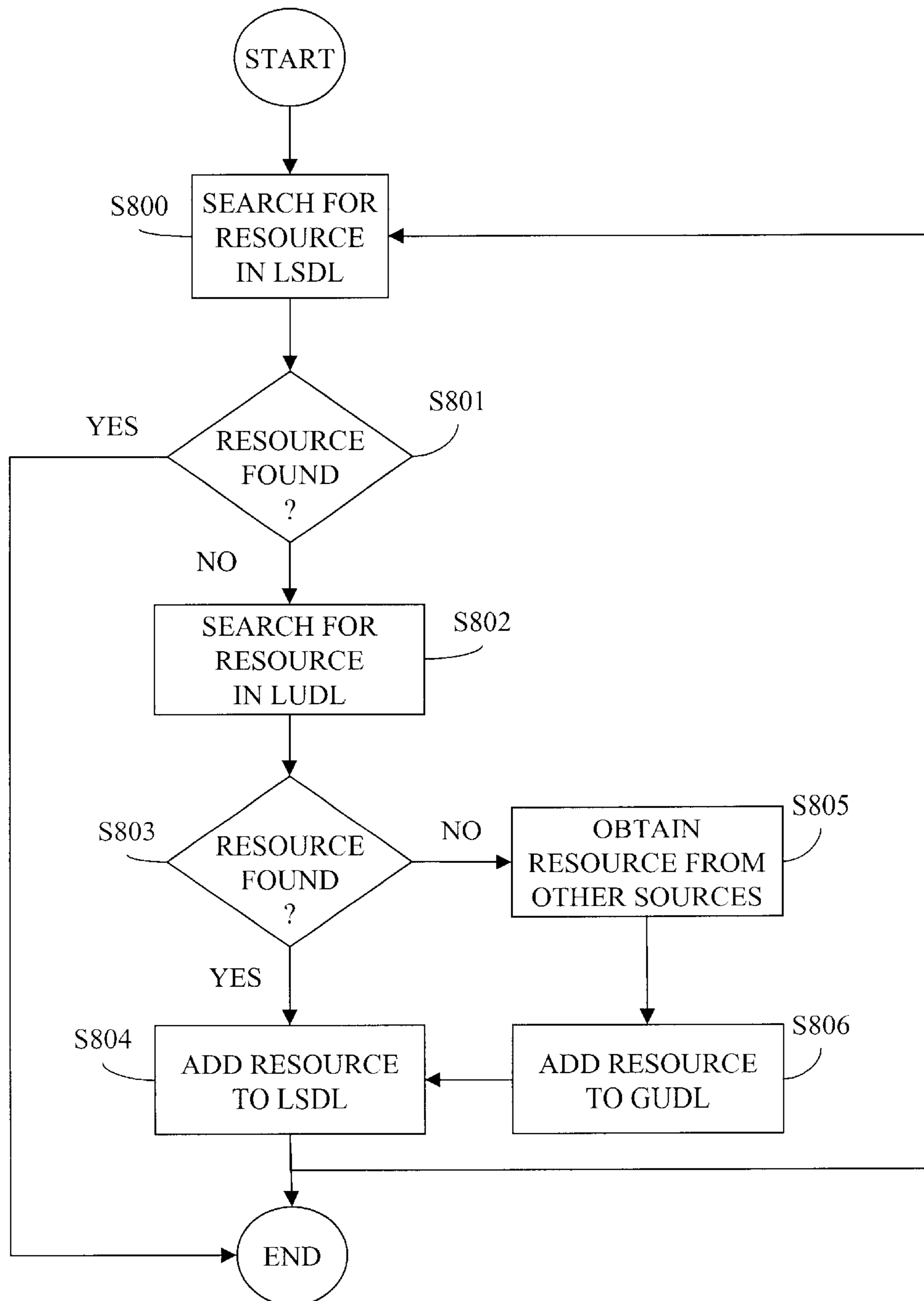




FIGURE 8



**FIGURE 9**

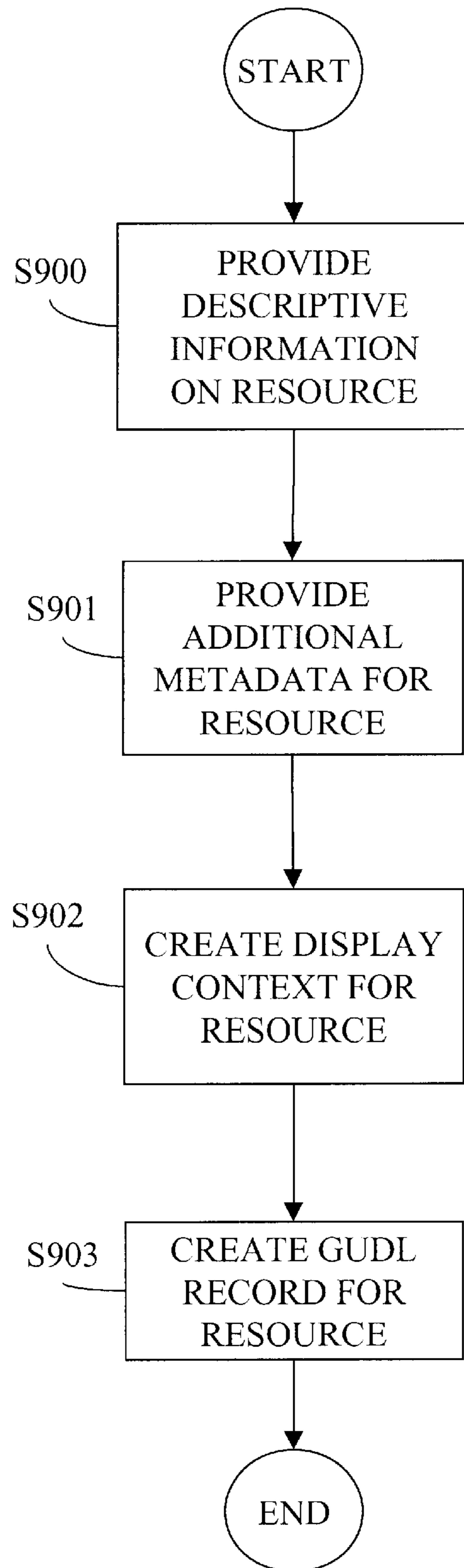
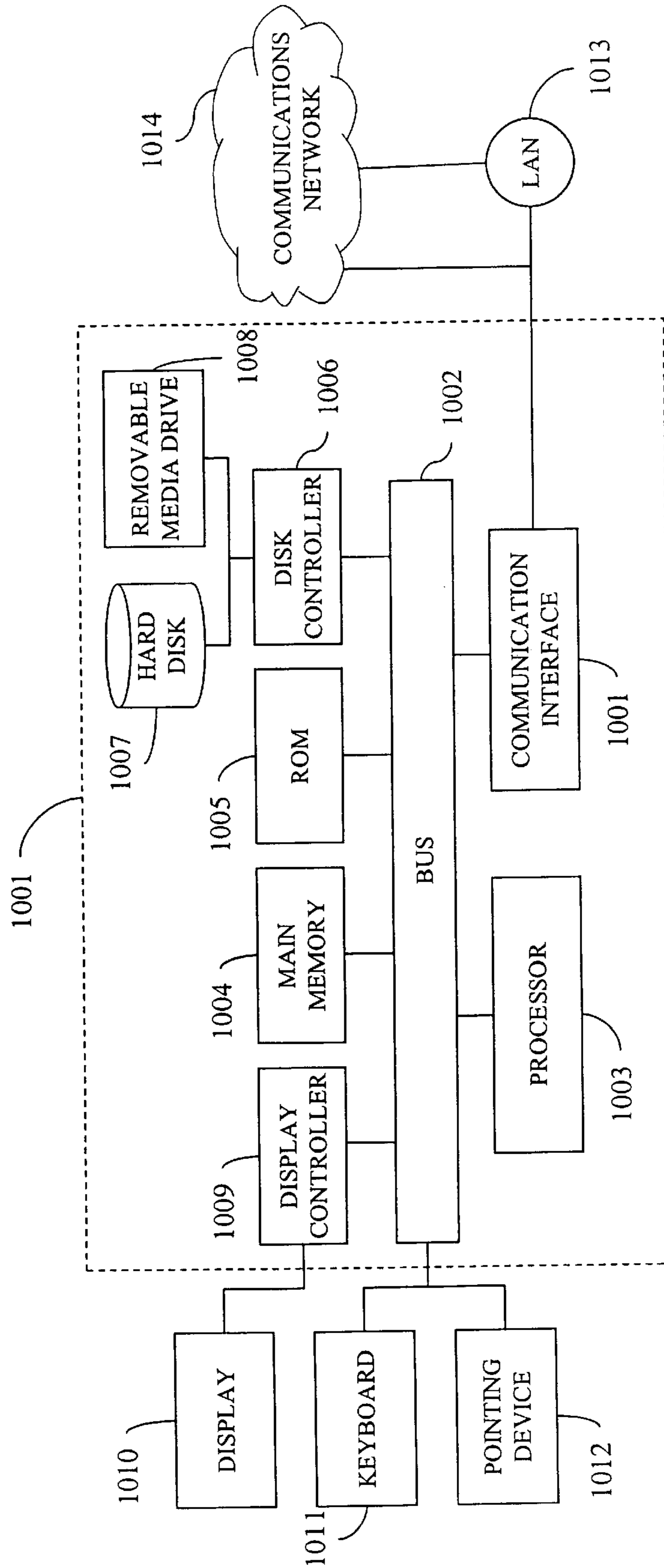


FIGURE 10





**SYSTEM, METHOD, AND COMPUTER  
PROGRAM PRODUCT FOR MANAGING  
ACCESS TO AND NAVIGATION THROUGH  
LARGE-SCALE INFORMATION SPACES**

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to systems, methods, and computer program products for managing and navigating large-scale information spaces, and more particularly, systems, methods, and computer program products for managing and navigating digital libraries.

2. Discussion of the Background

The "Principle of Least Effort" stands for the notion that when a user is confronted with an information system, the tendency is for the user to be satisfied with the information that can be easily found, as opposed to better information that would require more effort on the user's part to locate. The concept of the Principle of Least Effort is discussed at length in Chapter 8 of Mann, "Library Research Models: A Guide to Classification, Cataloging, and Computers," Oxford University Press, 1993, the entire contents of which are incorporated herein by reference. It is a primary objective of library professionals to design systems that can provide users with the highest quality information available and in a minimum amount of time and/or effort.

With the popularization of the Internet, the amount of information that has become available has become so large that it is not practical for users to search and assess the quality of all the information that is now available to them. While more information typically is beneficial, many professions have become hamstrung by an overabundance of information of variable quality readily available to them. One such example is the healthcare industry. Health insurance organizations, such as health maintenance organizations (HMOs) and planned provider organizations (PPOs) have placed restrictions on doctors that severely limits the amount of time that a doctor can spend on any given patient. One problem that this has presented to physicians is that the amount of time that they can spend researching a patient's condition has been severely limited.

The Internet has provided healthcare professionals a mechanism through which the most recent medical and research information can be accessed. However, given the amount of information that is available, and the severe limits on the physician's time available for research, it is impossible for the doctors to spend the time required to assess the quality of the information available to them. Therefore, it is not uncommon for doctors to rely on a limited, albeit trusted, set of information. One impact of this problem is that doctors are not being kept current on new developments in the medical field. Another impact of this problem is that patients may not be receiving the best care available since their physicians may not be aware of the most recent developments relating to a patient's condition.

In an effort to address these problems in the medical field, organizations have begun to develop large repositories of medical information that can be distributed to physicians. These organizations can then provide a service of sorting through new information as it becomes available, assess the quality of the information, and providing what they believe to be the best information available to their clients. This model for addressing the problem can provide a large number of physicians with access to a common repository of quality information. This approach is a step in the right

direction, but it is not without its problems. For example, it is to be expected that different physicians and different clinics will want access to different information. Physicians and clinics oftentimes provide specialized services, and accordingly, demand different levels of information for different specialties. Furthermore, aside from the medical specialities, it is not uncommon for physicians in different locations to want different levels of information for different medical conditions. For example, clinics located in urban areas are likely to see patients that have different conditions than those patients seen at a rural clinic.

Accordingly, it can be seen that conventional methods for providing access to large-scale information spaces are inadequate. In many cases, there is simply too much information available for the users to make sense of. In other cases, while the amount of information is manageable, the users have sacrificed their ability to control the content of information that they have access to. It is not practical to provide an information space that provides all content for all potential users. It would be advantageous to users of information if an approach were developed that allowed localized managers, such as local librarians, to provide their users with access to the content that was of most interest to their particular user population. The library professionals would become managers of links to content, rather than managers of the content itself. Such an approach would empower the library and information system professionals to collaboratively develop links to the best information that best meets the needs of their particular user population.

The librarians, or other managers of information, would be able to focus on gaining and organizing access to the content their users desire, and not be concerned with the overwhelming task of developing a library of the content itself. It would be advantageous if the librarians, through collaboration, could focus on navigation and access to content of interest, rather than the daunting task of creating their own content collection. Advantages to users of information will be provided by helping them to quickly navigate to the highest quality information of most interest to them. Through collaboration, the managers of the information will be able to tailor the navigation to their particular users' needs. The need for navigation tools to leverage the amount of information available over the Internet, for example, was discussed in Wurster, T., "Getting Real About Virtual Commerce," Harvard Business Review, President and Fellows of Harvard College, November 1999/December 1999, the entire contents of which is incorporated herein by reference.

As managers of large-scale information spaces, librarians would benefit from being able to track how their users are accessing the information. For example, it would be advantageous if a digital librarian could track the traversal path of users through a digital library so that those paths could be optimized based on historical usage patterns. It has been recognized that conventional server logs are very error prone, and therefore do not serve as a reliable source for such usage information. In particular, the inconsistent level of information maintained by conventional browsers and the caching levels of those browsers can lead to the creation of incomplete or inaccurate server logs. The difficulties presented in gathering reliable log information are discussed in detail in Fieber, J., "Browser Caching and Web Log Analysis," 1999 Mid-Year Meeting, American Society for Information Science, May 24-26, 1999, the entire contents of which is incorporated herein by reference. Therefore, conventional server logs have not provided a reliable source of usage information for librarians.



The challenge, then, as presently recognized, is to develop an approach and tools for library and information system professionals to provide navigation aids and access to a manageable amount of information that has been assessed for quality, and which is easily tailored to meet the needs of specialized groups of users. It would be advantageous if such a system were dynamic, meaning that the information available to the users of the system was constantly updated and arranged to facilitate navigation for the users of the information. It would be further advantageous if a feedback mechanism were provided that maintained accurate usage information on the users for the library professionals and other managers of information and enabled users to explicitly register their satisfaction with the real-world outcome of using the provided information (e.g., relevance rating, etc.).

#### SUMMARY OF THE INVENTION

The inventors of the present invention have recognized that currently no systems, methods, or computer program products are available to manage access to and navigation through large-scale information spaces in such a way that can meet the diverse, specialized needs of multiple subpopulations of users of the system. Accordingly, one object of the present invention is to provide tools for library and information system professionals or other managers of information that provide a solution to this problem, as well as other problems and deficiencies associated with managing and navigating large-scale information spaces.

The inventors of the present invention have also recognized that it would be advantageous to provide the ability to easily add resources to the information space, as well as to customize, for either individual users or groups of users with common interests, the view the user has into the information space. Accordingly, a further object of the present invention is to provide an interface that allows for resources that are not currently available in the information space to be easily catalogued and made available to the users of the system. It is another object of the present invention to provide a mechanism through which views of individual users or groups of users with common interests are tailored by adding resources of interest to them, and by allowing them to navigate through the information space without needing to traverse through information not of interest to them.

The present inventors have also recognized that it would be advantageous to track the navigational usage of their users, so that access and navigation patterns can be used to further tailor the presentation of the information space to the users. Accordingly, a further object of the present invention is to provide a reliable exactly-correct server log through which user patterns can be tracked for a variety of purposes.

The above described and other objects are addressed by the present invention which includes a novel computer-based system, method, and computer program product that manages and provides for easy navigation of large-scale information spaces.

In one embodiment, the present invention is implemented as an Internet-enabled clinical digital library. A server database includes an ontology of medical information that is constantly updated and added to, according to the needs of the users of managed digital libraries. The server database includes link information that is presented to the users of the digital library providing an access method (e.g., a deep-link) directly to the content of interest. The database also includes information describing the various views that have been customized for users and groups of users into the holdings of the library. The system also maintains an exactly-correct server log that tracks the use of the digital library by each of the users.

It is another object of the present invention to provide a software application program interface (API) to the capabilities of the present invention. By providing an API, the capabilities of the present invention may be readily incorporated into custom software applications directed to a variety of problems in which large-scale information access and/or navigation is a concern.

Consistent with the title of this section, the above summary is not intended to be an exhaustive discussion of all the features or embodiments of the present invention. A more complete, although not necessarily exhaustive, description of the features and embodiments of the invention is found in the section entitled "DESCRIPTION OF THE PREFERRED EMBODIMENTS."

#### BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the present invention, and many of the attendant advantages thereof, will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 is a block diagram showing an overall system configuration for one embodiment of the present invention;

FIG. 2 is a block diagram showing mechanisms of a digital librarian workstation, a library user workstation and a digital library server shown in FIG. 1;

FIG. 3 is a block diagram showing the interrelationship between the global union digital library, local union digital libraries, local specialized digital libraries, personal information spaces, and collegial views in one embodiment of the present invention;

FIG. 4 shows an exemplary hierarchical representation of the specialization of a local union digital library in one embodiment of the present invention;

FIG. 5 is an exemplary data field structure showing a digital library membership record for a particular user;

FIG. 6 is an exemplary data field structure showing an exactly-correct server log record;

FIG. 7 is a flow diagram of a process to specialize the views into a global union digital library in one embodiment of the present invention;

FIG. 8 is a flow diagram of a process to add an additional resource to a global union digital library in one embodiment of the present invention;

FIG. 9 is a flow diagram of a process to catalog a new resource to a global union digital library in one embodiment of the present invention; and

FIG. 10 is an exemplary computer system programmed to perform one or more of the special purpose functions of the present invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the figures, wherein like reference numerals designate identical or corresponding parts throughout the several views, and more particularly to FIG. 1 thereof, which is a block diagram of a system for managing access to and navigation through a large-scale information space. The present embodiment is discussed in the context of clinical digital libraries. However, the invention may be used in other contexts, for example, providing access to any large-scale information space where the managers and/or users of that information desire the ability to customize various views into the library. One such example would be



in the legal profession, where practitioners have specialized interests and require access to large amounts of information from a variety of sources. The present invention would be applicable to any organization or profession that is confronted with the problems of access to large amounts of information.

FIG. 1 shows that the system includes a digital library database **100**, a digital library server **101**, a communications network **102**, such as the Internet, a digital librarian workstation **103**, a library user workstation **104**, and many different repositories of content **105**. The various components of this system are linked together via a network link **L100**. The links between the digital library database **100** and the various repositories of content **105** are by references **R100** contained in the digital library database **100** indicating the location of the content, in one embodiment, the digital library database **100** is a link base of references. These references are hyperlinks that provide deep links directly to the specific location of the content **105** of interest.

The digital library server **101** is implemented using the computer system **1001** of FIG. 10, for example, but also may be any other suitable personal computer (PC), workstation, server, or device for communicating with the digital librarian workstation **103** and the library user workstation **104**, and for storing and retrieving information in the digital library database **100**.

The digital library database **100** is a digital repository that may be implemented, for example, through a commercially available relational database management system (RDBMS) based on the structured query language (SQL) such as, for example, ORACLE™ SYBASE™, INFORMIX™, DB/2 or MICROSOFT™ SQL SERVER™, through an object-oriented database management system (ODBMS), or through custom database management software. In one embodiment, the digital library database contains an ontology of the information contained in the digital library. For example, the digital library database may include a hierarchical organization of clinical information that had been specifically created for a physician seeing patients in a clinical setting (e.g., by an information professional or the physician him/herself). The digital library database **100** includes not only the hierarchical ontology of the information, but also access methods (e.g., hyperlinks) that provide direct links (e.g., deep links) to content **105** pertaining to each particular ontological category. Access methods include, but are not limited to hyperlinks to content **105** of interest. Data in the digital library database **100** is maintained by processes running on the digital library server **101**. The digital library database **100** may reside on a storage device of the digital library server **101**, or reside on another device connected to the digital library server **101**, for example, by way of a local area network, or other communications link such as a virtual private network, wireless link, or Internet-enabled link.

The digital library server **101** receives requests from, and provides information to, the digital librarian workstation **103** and the library user workstation **104**, by way of a connection to a communications network **102**. In one embodiment, the communications network **102** is the Internet. The digital librarian workstation **103** may be implemented using the computer system **1001** of FIG. 10, for example, or any other suitable PC, workstation, server, or device for communicating with the digital library server **101**, and accessing content **105** through a communications network **102**. The digital librarian workstation **103** is used by librarians to maintain and customize the ontological hierarchy maintained in the digital library database **100**, to create customized views into

the digital library database **100** to facilitate navigation through the information for users with specialized interests, and to add or remove access (e.g., hyperlinks) to content **105** from the digital library database **100**.

The library user workstation **104** may be implemented using the computer system **1001** of FIG. 10, for example, or any other suitable PC, workstation, server, or device for communicating with the digital library server **101** and accessing content **105** through a communications network **102**. The library user workstation **104** provides users of the digital library with a mechanism for accessing the information maintained in the digital library database **100** as links to content **105**.

FIG. 2 shows the mechanisms implemented by the digital library server **101**, the digital librarian workstation **103**, and the library user workstation **104** in greater detail. The librarian user interface **200** provides a mechanism through which librarians can manage which content **105** is available through the digital library, as well as a mechanism through which the ontology held in the digital library database **100** may be maintained. In one embodiment, the librarian user interface **200** is implemented through displayable pages accessible through the digital library server **101** using a commercially available web browser tool including, but not limited to INTERNET EXPLORER™, available from MICROSOFT CORPORATION™, and NETSCAPE NAVIGATOR™, available from NETSCAPE COMMUNICATIONS CORPORATION™.

Processes on the digital library server **101** build the pages (e.g., hypertext markup language (HTML) pages, extensible HTML (XHTML), or dynamic HTML (DHTML) pages) which serve as the librarian user interface **200** and the library user navigation user interface **201**. In one embodiment, the processes running on the digital library server **101** responsible for interacting with the digital librarian workstation **103** and the library user workstation **104** are developed using software development environment such as WEBSPHERE™, VISUALAGE FOR JAVA™, both available from IBM, and JavaScript.

HTML, XHTML, and DHTML are standard markup languages as would be well understood by one of ordinary skill in the software art. XHTML is a version of HTML written in extensible markup language (XML), which is another standard markup language as would be well understood by one of ordinary skill in the software art. HTML and XHTML are described in Musciano et al., "HTML & XHTML: The Definitive Guide," O'Reilly & Associates, 4<sup>th</sup> Edition, August 2000, the entire contents of which are incorporated herein by reference. DHTML is described in Goodman, D., "Dynamic HTML: The Definitive Reference," O'Reilly & Associates, 1<sup>st</sup> Edition, July 1998, the entire contents of which are incorporated herein by reference. XML is described in Marchal, B., "XML By Example," Que, December 1999, and Harold, E., "XML Bible," IDG Books Worldwide, Book and CD ROM Edition, July 1999, the entire contents of both of which are incorporated herein by reference. WEBSPHERE™ and VISUALAGE™ programming are described in Ben-Natan et al., "IBM WebSphere Starter Kit," Osborne McGraw Hill, Book and CD ROM Edition, May 16, 2000, and IBM International Technical Support Organization (IBM Redbooks), "IBM WebSphere and VisualAge for Java Database Integration with DB2, Oracle, and SQL Server," IBM Corporation, September 1999, the entire contents of both of which are incorporated herein by reference. JavaScript is described in Flanagan, D., "JavaScript: The Definitive Guide," O'Reilly & Associates, 3<sup>rd</sup> Edition, June 1998, the entire contents of which are incorporated herein by reference.



The library user navigation user interface **201**, like the librarian user interface **200**, is the mechanism through which end users of the digital library interact with the digital library database **100** in order to navigate to and access content **105** available through the digital library. The library user navigation user interface **201** includes a mechanism through which users of the digital library with special privileges may access some of the capabilities that would otherwise only be accessible through the librarian user interface **200**. For example, some users may be given the ability to add access to, for example, a hyperlink to new content **105**, to the holdings of the digital library database **100**. As with the librarian user interface **200**, the library user navigation user interface **201** may be implemented as browsable pages built by processes running on the digital library server **101**, and sent through the communications network **102** to the library user workstation **104**.

The library ontology management mechanism **202** interacts with the digital library database **100** to present the appropriate information to the users of the digital library. For example, in response to a selection of a high-level topic by a user, the library ontology management mechanism **202** will query the digital library database **100** through the digital library database management mechanism **203** and create a page that presents to the user the subordinate topics available for that selected topic, as identified by the ontology maintained in the digital library database **100**. As the user selects more detailed topics, the library ontology management mechanism **202** will return access methods (e.g., hyperlinks) to content **105** corresponding to those topics of interest. As a user selects a hyperlink presented on the library user navigation user interface with, for example, a mouse "click," the user will link directly to the content **105** corresponding to that hyperlink through a communications network **102**, for example, the Internet. By maintaining access methods to content **105**, rather than the content **105** itself, the digital library holds deep links that link directly to the information of interest, thereby facilitating the users' navigation. Linking to content **105** over the Internet via a hyperlink embedded in a browsable page is a common user interface approach as would be well understood by one of ordinary skill in the software art, and the concepts are described in Gralla, P., "How the Internet Works," Que, Millenium Edition, August 1999, the entire contents of which are incorporated herein by reference.

The digital library database management mechanism **203** generates queries based on inputs through the librarian user interface **200** or the library user navigation user interface **201**. Those queries are issued to the digital library database **100** under the digital library database management mechanism **203** which also receives the results of the queries. The results of the queries, for example, a list of ontological sub-topics for a selected topic are then presented to the user through either the librarian user interface **200** or the library user navigation user interface **201**, as appropriate.

The library content-access management mechanism **204** maintains the links providing access to the content **105** associated with the ontological hierarchy in the digital library database **100**. Through the library content-access management mechanism **204**, the librarian user interface **200** can be used to add or remove hyperlinks to content **105**. Also, the library content-access management mechanism **204** creates the various specialized views that facilitate navigation within the digital library. A specialized view allows a user to be presented only with that information that is of most interest to him or her. For example, while the ontology may represent a variety of medical specialties at

great detail, a particular user (e.g., an allergist), may only want to see a subset of this information when they access the digital library. While the capability to create a specialized view and add access to content **105** is usually reserved for librarian or manager users, certain other users may be given the ability to manipulate their view and/or content by being given access to the content-access management mechanism **204**.

The library ontology customization mechanism **205** is used by librarians through the librarian user interface **200** to adjust the ontological hierarchy maintained in the digital library database **100**. Both the library content-access management mechanism **204** and the library ontology customization mechanism **205** interact with the digital library database **100** through the digital library database management mechanism **203**.

The server log management mechanism **206** tracks the navigation of the digital library by the users and maintains a log of this information in, for example, the digital library database **100**. The server log management mechanism **206** generates an exactly-correct server log by capturing each user's interaction with the digital library database **100** through the digital library database management mechanism **203**. The availability of an exactly correct server log will facilitate the librarian's duties by providing insight as to which paths through the ontology are most commonly taken by users navigating the digital library. Conventional server logs have proven to be too error prone, and therefore can not be relied on. With this information, librarians or managers are able to customize the ontology through the library ontology customization mechanism **205** as accessed through the librarian user interface **200** accordingly.

As discussed above, in one embodiment, all of the mechanisms shown in FIG. 2 may be implemented using a software development environment such as WEBSPIHERE™ and VISUALAGE™ available from IBM™. Processes running on the digital library server **101** can respond to requests received through a communications network **102**, such as the Internet, from users using a library user workstation **104** or librarians using a digital librarian workstation **103**. Those processes running on the digital library server **101** may respond to requests by creating the appropriate SQL query, issuing the query to the digital library database **100**, receiving results from those queries, then creating an appropriate page that can be displayed by the librarian user interface **200** or the library user navigation user interface **201** that is responsive to the request. When the pages sent to the digital librarian workstation **103** or the library user workstation **104** include hyperlinks to content **105**, the users of the system can simply select that hyperlink through the librarian user interface **200** or the library user navigation user interface **201** using an appropriate selection mechanism such as a mouse or other pointing device, and directly link to the content **105** of interest through a communications network **102**, such as the Internet. Accordingly, it can be seen that the digital library database **100** need not store the content **105** itself, but rather, manage the presentation of the ontological hierarchy to the users, and provide hyperlinks to the content **105** of interest.

A role of library professionals, then, includes finding content **105** that best meets the needs of the users. A librarian can then provide access to the content **105** by adding an access method (e.g., a hyperlink) to the digital library database **100** through the library content-access management mechanism **204**. Furthermore, the librarian can analyze the exactly-correct server log generated by the server log management mechanism **206** to gain insight into their users'



navigation patterns. As discussed in the BACKGROUND OF THE INVENTION section, users tend to rely on information most easily found, rather than better information that is more difficult to find. Through the library content-access management mechanism **204** and the library ontology customization mechanism **205**, as accessed through the librarian user interface **200**, librarians can be constantly finding better content **105** for their users, and moreover, can be arranging access to that content **105** such that the best content **105** is the most easily available. The present inventors have recognized that the Principle of Least Effort, as discussed in the BACKGROUND OF THE INVENTION section, can be leveraged by continuously refining the organization and presentation of information that is most valued by users. The present invention provides an approach for information professionals to be responsive to users, thereby better-serving the users by leveraging their known idiosyncratic behavior.

In one embodiment, the functionality provided through the mechanisms shown in FIG. 2 is accessible through a software application program interface (API) **207** so that other software applications can easily incorporate it. The API **207** includes function calls that when invoked by a calling software application allow that application to, for example, communicate with a digital library server **101** and/or access information being maintained in a digital library database **100**. As another example, the API **207** provides the calling software application with access to the exactly-correct server log information. As would be well understood by one of ordinary skill in the software art, an API **207** to the functionality of the present invention provides a mechanism through which navigation tools for large-scale information spaces may be integrated into any software application.

FIG. 3 is a block diagram showing the interrelationships between various views of the information maintained in the digital library database **100** using an exemplary specialization scheme. As would be well understood by one of ordinary skill in the library science art, a variety of specialization schemes could be devised.

In one embodiment, the global union digital library (GUDL) **300** represents a virtual universe of all of the content **105** that could be potentially accessed through an access method stored within the digital library database **100**. It should be noted that more than one digital library may reside within a particular digital library database **100**. Within the digital library database **100**, various local union digital libraries (LUDLs) **301A**, **301B**, **301C** may be created which will provide a common view to certain users that have interests in a common subset of the GUDL **300** holdings. Referring to the example illustrated in FIG. 3, three different LUDLs **301A**, **301B**, **301C**, which may or may not overlap with one another may exist, all containing access to content **105** that is accessible within the virtual GUDL **300**. In FIG. 3, the first LUDL **301A** overlaps with the second LUDL **301B** (illustrated in FIG. 3 with a dotted line border and shading), whereas the third LUDL **301C** does not overlap with any other LUDLs. In other embodiments, the GUDL **300** may have boundaries that are established by the library professional or other manager of the information.

Within a LUDL **301A**, **301B**, **301C**, one or more local specialized digital libraries (LSDLs) **302** can be created to provide a view into a more specialized area of the LUDL **301A**, **301B**, **301C**. As shown in FIG. 3, the LSDLs **302** may or may not overlap one another.

As shown in FIG. 3, all LUDLs **301A**, **301B**, **301C**, are within the GUDL **300**. Also, all LSDLs **302** are contained within a LUDL **301A**, **301B**, **301C**.

As discussed above, a specialized view into the GUDL **300** may be created for those users that have specialized needs. As shown in FIG. 3, a personal information space (PIS) **303** or a collegial view (CV) **304** may be created for these types of users. In this exemplary scheme, those users that have access to a PIS **303** or a CV **304** are given access to functionality implemented by the library content-access management mechanism **204** to control which content **105** is accessible through their view. Accordingly, those users with a PIS **303** or CV **304** may add links to content **105** to the digital library database **100** that will be included in their view that is not necessarily included in the LUDL **301A**, **301B**, **301C** that they originally had as a view. Through such a process, these special users, or alternatively, the library professionals or other information managers, may enrich the LUDLs **301A**, **301B**, **301C** by managing the navigation through, or adding access to new content **105** to the LUDLs **301A**, **301B**, **301C**.

By having the ability to create specialized views into the GUDL **300**, librarians are able to focus their users on the content **105** that is of the most interest to them. While all information in the GUDL **300** is potentially available to all users, only that content **105** that is of the most interest to a particular group of users is presented to them as their primary view. Moreover, librarians, through access to the exactly-correct server log information or through user input, collaborate with one another to ease the navigation through the digital library for their particular user populations.

FIG. 4 shows an example of how views into a virtual GUDL **300** may be specialized to accommodate the interests of different groups of users. As shown in FIG. 4, within a virtual GUDL **300**, a particular hospital may be interested in only a subset of the information available in the GUDL **300**. As such, a librarian representing that hospital may create a LUDL **301A**, **301B**, **301C** to include that subset of information of particular interest to that hospital. It should be noted that all information available in the GUDL **300** would remain available to the hospital that has established a LUDL **301A**, **301B**, **301C**, however, those users belonging to the hospital will be presented with a specialized interface into the GUDL **300** that more readily facilitates access to that information within the LUDL **301A**, **301B**, **301C**. An example of why a hospital may create a LUDL **301A**, **301B**, **301C** would be where that particular hospital does not practice a particular specialty for which information is available in the GUDL **300**. Accordingly, the librarian for the hospital would create a LUDL **301A**, **301B**, **301C** that privileges that information of most interest to that library's users. As such, the librarian would not privilege information pertaining to specialties that are not of preeminent interest at that particular hospital. The concept of privileging information is understood by those of ordinary skill in the library art, and is discussed in Buckland, M., "What Will Collection Developers Do?," Information Technology and Libraries, September 1995, the entire contents of which are incorporated herein by reference.

Continuing with FIG. 4, the librarian for a particular department within the hospital may wish to further specialize the view into the GUDL **300** beyond the specialization created by the LUDL **301A**, **301B**, **301C**. For example, a dermatology department may wish to create an LSDL **302** that includes only dermatological information, thereby providing an even more focused view for that librarian's customers. Furthermore, using this specialization technique, a particular doctor may wish to have his own PIS **303** created within the LSDL **302** that was created for the Department of Dermatology. The PIS **303** view into the



LSDL **302** may be created, for example, to support a special research project. In doing so, the librarian may wish to provide the individual with specialized access, that will enable them to find their own content **105** to include into their PIS **303** view. Similar to a PIS **303** would be a collegial view (CV) **304**. A CV **304** is merely a PIS **303** for a group of individuals with like interests.

In working closely with the users of the digital library, librarians can further customize either the views or the content **105** to address the needs of their users. Moreover, local librarians can use the present invention to collaborate with one another or with a centralized librarian in order to provide their user populations with the most effective navigation and most useful information available. By constantly refining which content **105** is accessible through the digital library, and how the users navigate through that content **105**, the users of the digital library are avoiding the pitfalls of the Principle of Least Effort, discussed in the BACKGROUND OF THE INVENTION section, by constantly gaining easier access to better content **105**. Not only can the users work explicitly with the librarian to achieve these goals, but through the exactly-correct server log, the librarians can make their own assessment as to the best organization of the content **105** for their particular user population.

Furthermore, as discussed in the BACKGROUND OF THE INVENTION section, by having local librarians refine the navigation through and access to the content **105**, the digital library becomes fine-tuned to a particular user population. The present invention provides tools for library and information system professionals to maximize their users leverage of information. Since the views into the GUDL **300** are optimized for local use, different users will be presented with different results to a common search of the digital library. By tapping into the experience and feedback mechanism provided by library professionals, the users are will increasingly benefit from their use of the digital library. Library professionals can share information that will allow them to learn from the successes and failures of other professionals in customizing the navigation and content **105** accessible through the views into the GUDL **300** under their responsibility.

FIG. 5 shows a structure of one example of a record whereby the digital library server **101** can determine which view of the GUDL **300** to present through a librarian user interface **200** or a library user navigation user interface **200** for a particular user. As shown in FIG. 5, the message includes a user ID field **500** by which the user is identified. The digital library membership field **501** identifies which LUDL **301A**, **301B**, **301C** should be presented to the user. The digital library ontology field **502** identifies which view (i.e., LUDL **301A**, **301B**, **301C**, LSDL **302**, PIS **303**, or CV **304**) into the LUDL **301A**, **301B**, **301C** corresponds to the user identified in the user ID **500**. As described above, the views are a customized or filtered presentation of the ontology maintained in the digital library database **100** according to a user's or a group of user's preferences and/or access privileges. By storing the view of the GUDL **300** with the user ID **500**, the digital library server **101** may efficiently manage a system containing large numbers of users and specialized views. The content **105** accessible by the digital library is then navigable through the various views into the LUDL **301A**, **301B**, **301C**.

FIG. 6 shows a structure of one example of a record containing log entries tracking the traversal through a digital library by a particular user. As shown in FIG. 6, the record provides data including a user ID field **600** identifying the user, a time field **601**, identifying the time that user visited

a particular location within the library, an ontological path followed field **602** identifying the exact hyperlink from the link base followed, an exit link field **603**, identifying the exit point hyperlink from the link base followed by the user when linking to content external to the digital library, and a quality feedback field **604**, for capturing qualitative feedback from the user as to the usefulness of the information contained at the location exited to. As would be understood by one of ordinary skill in the library art, the information captured by the exit link field **603** is analogous to recording which book was checked out by a user of a brick-and-mortar library. By maintaining a record for each location followed by each user, an exactly-correct server log may be maintained in the digital library database **100**. As discussed above, such a log provides valuable insight for a librarian as to how the information maintained in the digital library is navigated by the users and can provide a variety of informational purposes. Furthermore, the present invention facilitates an iterative improvement process by providing a mechanism (e.g., the quality feedback field **604**) through which qualitative feedback can be provided by the users to the library professionals. Librarians and other managers of the digital library will be empowered by having both quantitative (e.g., an accurate log of usage information) and qualitative (e.g., quality feedback information) feedback as to the usage patterns and satisfaction of the users of the library. With this information, library professionals may adjust the presentation of the information by refining the ontology and privileging the most-favored content to cater to the library users' usage and feedback.

FIG. 7 shows a process through which specialized views into a global union digital library **300** can be created by a librarian. As shown in FIG. 7, the process begins with step **S700** where the digital digital library is initialized with a core. A core defines an ontology and is provided with links to the initial content **105** holdings of the digital library, and will therefore typically be targeted to a broad population of users. After the digital library has been initialized with the core at step **S700**, the process can either end or proceed to step **S701** where the core content **105** of the digital library is enriched with links to further content **105**. If the process ends after step **S700**, all users of the digital library will have the same view into the digital library which will contain access to only the core content **105**. At step **S701** it is possible for a librarian to not only specialize the ontology by effecting changes for a particular user or group of users, but also to enrich the core content **105** by adding access to content **105** that is of particular interest to that librarians's user population.

After the digital library has been enriched with access to further content **105** at step **S701**, the process can end, the librarian can create a local union digital library **301A**, **301B**, **301C** within the digital library at step **S702**, or the librarian may create a personal information space **303** or a collegial view **304** within the digital library at step **S703**. If the librarian creates a LUDL **301A**, **301B**, **301C** within the digital library at step **S702**, the librarian will arrange those portions of the ontology that are of particular interest to that librarian's user population into a new view that will be presented via the library user navigation user interface **200** to that user population. Creating a LUDL **301A**, **301B**, **301C** does not remove access to any content **105** from the digital library system, it merely facilitates navigation to the information of most interest to a particular user population as the primary content **105**. Similarly, if a PIS **303** or CV **304** is created within the digital library at step **S703**, the result is a specialized view facilitating navigation through the content



**105** accessible through the digital library for a single individual (PIS **303**) or a small group of individuals (CV **304**) with common interests. In one embodiment, when a PIS **303** or a CV **304** is created, those specialized users are given access to functionality normally reserved for librarians through the librarian user interface **200**, so that those users may add access to content **105** to the digital library that meets their specialized needs. After a PIS **303** or CV **304** has been created within the digital library at step **S703**, the process ends.

After a LUDL **301A**, **301B**, **301C** has been created at step **S702**, the process may end, the librarian may create a local specialized digital library **302** within the LUDL **301A**, **301B**, **301C** at step **S704**, or a librarian may create a PIS **303** or CV **304** within the LUDL **301A**, **301B**, **301C** at step **S705**. If the librarian creates a PIS **303** or CV **304**, the process is the same as that described above in regard to step **S703**, except that the librarian may create the PIS **303** or CV **304** within the LUDL **301A**, **301B**, **301C** created at step **S702**.

At step **S704**, the librarian creates a LSDL **302** within the LUDL **301A**, **301B**, **301C** created at step **S702**. While a LUDL **301A**, **301B**, **301C** may be specialized with regard to the organization's interest, the LSDL **302** may correspond to the information of interest to a department within that organization, for example. With each level of specialization, the librarian is providing a particular set of users with a more specialized and focused view into the information accessible through the digital library. Accordingly, each user can be more productive by having a specialized view into the digital library. Without this specialization, users would inevitably have to repeatedly navigate through information not of interest to them so as to access information that is of interest to them.

After the librarian has created a LSDL **302** at step **S704**, the process may end, or the librarian may create a PIS **303** or CV **304** from the LSDL **302** at step **S706**. As discussed above, in regard to steps **S703** and step **S705**, the PIS **303** or CV **304** may be created to further specialize a view into the content **105** accessible through the digital library.

As would be appreciated by one of ordinary skill in the library art, this specialization process described in FIG. 7 is an iterative and ongoing process further refining the presentation of the ontology and further refining the navigation to the content **105** accessible through the digital library for the various user populations of the digital library. As users desire access to more content or more efficient navigation through the content already accessible, the users can make the appropriate requests of their librarian. In one embodiment, the library user navigation user interface **201** includes a mechanism through which users may communicate their requests directly to their librarian through, for example, an e-mail message.

FIG. 8 shows a process through which access to an additional resource may be added to a local union digital library **301A**, **301B**, **301C**. As shown in FIG. 8, the process begins with step **S800** where a user searches for a resource within their local specialized digital library **302**. Since the LSDL **302** is a specialized view into the LUDL **301A**, **301B**, **301C**, a search for a resource within a LSDL **302** will also search within the LSDL's **302** LUDL **301A**, **301B**, **301C** for that resource. At step **S801**, it is determined whether the resource being searched for can be located. If the resource can be found within the LSDL **302** or the LSDL's **302** LUDL **301A**, **301B**, **301C**, the process ends. However, if the resource cannot be found within the LSDL **302** or the LSDL's **302** LUDL **301A**, **301B**, **301C**, the resource is

searched for within the global union digital library **300** at step **S802**. At step **S803**, it is determined whether the resource being searched for at step **S802** can be found within the GUDL **300**. If the resource being searched for is found within the GUDL **300**, access to that resource (e.g., a hyperlink) is added to the LSDL **302** at step **S804**. Since the LSDL **302** is a subset of the LUDL **301A**, **301B**, **301C**, by adding the access to the found resource to the LSDL **302**, that access is also added to the LUDL **301A**, **301B**, **301C**. However, if the resource being searched for cannot be found within the GUDL **300**, the process proceeds to step **S805** where that resource is obtained from other sources. After the resource is obtained from another source at step **S805**, the process proceeds to step **S806** where that resource is added to the GUDL **300**. Once the resource has been added to the GUDL **300** at step **S806**, the process proceeds to step **S804** where access to that resource is added to the LSDL **302** that was originally searched. After access to the resource is added to the LSDL **302**, the process may either return to step **S800** where it may be verified that the new resource has been successfully added, or the process ends. As discussed above, adding access to a resource includes adding, for example, a hyperlink or deep link at the appropriate level within the ontological hierarchy that is maintained in the digital library database **100**. Accordingly, it is not necessary to obtain the content **105** itself, but rather, an address, or hyperlink, directly related to that content **105**.

FIG. 9 shows a process through which access to a new resource is catalogued to an existing digital library. As shown in FIG. 9, the process begins with step **S900** where descriptive information regarding that resource is provided. The librarian user interface **200** will include a mechanism through which this information is requested if the librarian, or other user, is bringing new content **105** into the LUDL **301A**, **301B**, **301C**. After the descriptive information has been provided, the process proceeds to step **S901** where additional metadata for the resource is added. As would be well understood by one in the software art, metadata will facilitate the searching for a particular resource, and by adding additional metadata, the librarian can facilitate the location of a particular resource. The metadata that is added will be maintained with the digital library. Accordingly, the metadata may include not only descriptive information, such as author and subject, but also information that will be used to manage the display and prominence of the resource. For example, metadata may be used by librarians or other individuals managing their own information (e.g., via a Personal Information Space (PIS) **303**) to privilege the resources in the digital library based on quality feedback received or, in the case of a PIS **303**, for example, their own personal desires. Because the metadata is maintained with the digital library, different libraries accessing the same resource may have privileged those common resources differently to cater to that library's users. The present inventors have recognized that it would be advantageous if a role of the digital librarian would be to enrich the content **105** that is accessible to the library's users as well as to privilege those resources according to the feedback provided by that particular library's users.

After the additional metadata has been added at step **S901**, the process proceeds to step **S902** where a display context is created for the new resource. In this step, an initial indentation and privileging of the resource is established. Of course, as described above, the resource may be re-privileged based on quality feedback regarding that resource received by the librarian from the users of that resource. After the display context for the resource has been



created at step **S902**, the process proceeds to step **S902** where a record is created for that resource in the digital library database **100**. The librarian, or individual managing their own digital library, will place the resource at the appropriate location within the ontological hierarchy. Furthermore, the librarian will include that new resource into the appropriate specialized views (i.e., LUDL **301A**, **301B**, **301C**, LSDL **302**, PIS **303**, or CV **304**).

By continuously adding requested content **105** and further specializing the views into the LUDL **301A**, **301B**, **301C**, librarians can help their user populations gain efficient access to the most recent and highest quality information available. Furthermore, different users of a LUDL **301A**, **301B**, **301C** may access different content **105** in response to this same question. For example, librarians may create multiple local specialized digital libraries **302** for multiple clinics, each clinic serving a different demographic of patients. Accordingly, some resources may be more applicable to one patient demographic than another. As such, each clinic may access different content **105** that is most applicable to the demographic of their clientele.

The system of the present invention, therefore, addresses not only the problems caused by the Principle of Least Effort, but also the problems created by such vast quantities of information being available. By empowering librarians to tailor not only which content **105** will be accessible, but also views into the content facilitating their users' navigation through the digital library, librarians can empower their user population by providing them current, quality, and relevant information that is quickly navigated to, rather than merely providing them with an ability to search a seemingly endless supply of information.

All or a portion of the invention may be conveniently implemented using conventional general purpose computers or microprocessors programmed according to the teachings of the present invention, as will be apparent to those skilled in the computer art. Appropriate software can be readily prepared by programmers of ordinary skill based on the teachings of the present disclosure, as will be apparent to those skilled in the software art.

FIG. **10** illustrates a computer system **1001** upon which an embodiment of the present invention may be implemented. The computer system **1001** includes a bus **1002** or other communication mechanism for communicating information, and a processor **1003** coupled with the bus **1002** for processing the information. The computer system **1001** also includes a main memory **1004**, such as a random access memory (RAM) or other dynamic storage device (e.g., dynamic RAM (DRAM), static RAM (SRAM), synchronous DRAM (SDRAM), and flash RAM), coupled to the bus **1002** for storing information and instructions to be executed by processor **1003**. In addition, the main memory **1004** may be used for storing temporary variables or other intermediate information during the execution of instructions by the processor **1003**. The computer system **1001** further includes a read only memory (ROM) **1005** or other static storage device (e.g., programmable ROM (PROM), erasable PROM (EPROM), and electrically erasable PROM (EEPROM)) coupled to the bus **1002** for storing static information and instructions for the processor **1003**.

The computer system **1001** also includes a disk controller **1006** coupled to the bus **1002** to control one or more storage devices for storing information and instructions, such as a magnetic hard disk **1007**, and a removable media drive **1008** (e.g., floppy disk drive, read-only compact disc drive, read/write compact disc drive, compact disc jukebox, tape drive,

and removable magneto-optical drive). The storage devices may be added to the computer system **1001** using an appropriate device interface (e.g., small computer system interface (SCSI), integrated device electronics (IDE), enhanced-IDE (E-IDE), direct memory access (DMA), or ultra-DMA).

The computer system **1001** may also include special purpose logic devices (e.g., application specific integrated circuits (ASICs)) or configurable logic devices (e.g., simple programmable logic devices (SPLDs), complex programmable logic devices (CPLDs), and field programmable gate arrays (FPGAs)).

The computer system **1001** may also include a display controller **1009** coupled to the bus **1002** to control a display **1010**, such as a cathode ray tube (CRT), for displaying information to a computer user. The computer system **1001** includes input devices, such as a keyboard **1011** and a pointing device **1012**, for interacting with a computer user and providing information to the processor **1003**. The pointing device **1012**, for example, may be a mouse, a trackball, or a pointing stick for communicating direction information and command selections to the processor **1003** and for controlling cursor movement on the display **1010**. In addition, a printer may provide printed listings of the data structures/information shown in FIGS. **3** and **4**, or any other data stored and/or generated by the computer system **1001**.

The computer system **1001** performs a portion or all of the processing steps of the invention in response to the processor **1003** executing one or more sequences of one or more instructions contained in a memory, such as the main memory **1004**. Such instructions may be read into the main memory **1004** from another computer readable medium, such as a hard disk **1007** or a removable media drive **1008**. One or more processors in a multi-processing arrangement may also be employed to execute the sequences of instructions contained in main memory **1004**. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions. Thus, embodiments are not limited to any specific combination of hardware circuitry and software.

As stated above, the computer system **1001** includes at least one computer readable medium or memory for holding instructions programmed according to the teachings of the invention and for containing data structures, tables, records, or other data described herein. Examples of computer readable media are compact discs, hard disks, floppy disks, tape, magneto-optical disks, PROMs (EPROM, EEPROM, Flash EPROM), DRAM, SRAM, SDRAM, or any other magnetic medium, compact discs (e.g., CD-ROM), or any other optical medium, punch cards, paper tape, or other physical medium with patterns of holes, a carrier wave (described below), or any other medium from which a computer can read.

Stored on any one or on a combination of computer readable media, the present invention includes software for controlling the computer system **1001**, for driving a device or devices for implementing the invention, and for enabling the computer system **1001** to interact with a human user (e.g., a digital librarian or a digital library user). Such software may include, but is not limited to, device drivers, operating systems, development tools, and applications software. Such computer readable media further includes the computer program product of the present invention for performing all or a portion (if processing is distributed) of the processing performed in implementing the invention.

The computer code devices of the present invention may be any interpretable or executable code mechanism, includ-



ing but not limited to scripts, interpretable programs, dynamic link libraries (DLLs), Java classes, and complete executable programs. Moreover, parts of the processing of the present invention may be distributed for better performance, reliability, and/or cost.

The term "computer readable medium" as used herein refers to any medium that participates in providing instructions to the processor **1003** for execution. A computer readable medium may take many forms, including but not limited to, non-volatile media, volatile media, and transmission media. Non-volatile media includes, for example, optical, magnetic disks, and magneto-optical disks, such as the hard disk **1007** or the removable media drive **1008**. Volatile media includes dynamic memory, such as the main memory **1004**. Transmission media includes coaxial cables, copper wire and fiber optics, including the wires that make up the bus **1002**. Transmission media may also take the form of acoustic or light waves, such as those generated during radio wave and infrared data communications.

Various forms of computer readable media may be involved in providing one or more sequences of one or more instructions to the processor **1003** for execution. For example, the instructions may initially be carried on a magnetic disk of a remote computer. The remote computer can load the instructions for implementing all or a portion of the present invention remotely into a dynamic memory and send the instructions over a telephone line using a modem. A modem local to the computer system **1001** may receive the data on the telephone **10** line and use an infrared transmitter to convert the data to an infrared signal. An infrared detector coupled to the bus **1002** can receive the data carried in the infrared signal and place the data on the bus **1002**. The bus **1002** carries the data to the main memory **1004**, from which the processor **1003** retrieves and executes the instructions. The instructions received by the main memory **1004** may optionally be stored on a storage device **1007** or **1008** either before or after execution by the processor **1003**.

The computer system **1001** also includes a communication interface **1013** coupled to the bus **1002**. The communication interface **1013** provides a two-way data communication coupling to a network link **1014** that is connected to, for example, a local area network (LAN) **1015**, or to another communications network **1016** such as the Internet. For example, the communication interface **1013** may be a network interface card to attach to any packet switched LAN. As another example, the communication interface **1013** may be an asymmetrical digital subscriber line (ADSL) card, an integrated services digital network (ISDN) card, or a modem to provide a data communication connection to a corresponding type of communications line. Wireless links may also be implemented. In any such implementation, the communication interface **1013** sends and receives electrical, electromagnetic or optical signals that carry digital data streams representing various types of information.

The network link **1014** typically provides data communication through one or more networks to other data devices. For example, the network link **1014** may provide a connection to a another computer through a local network **1015** (e.g., a LAN) or through equipment operated by a service provider, which provides communication services through a communications network **1016**. In preferred embodiments, the local network **1014** and the communications network **1016** preferably use electrical, electromagnetic, or optical signals that carry digital data streams. The signals through the various networks and the signals on the network link **1014** and through the communication interface **1013**, which carry the digital data to and from the computer system **1001**,

are exemplary forms of carrier waves transporting the information. The computer system **1001** can transmit and receive data, including program code, through the network(s) **1015** and **1016**, the network link **1014** and the communication interface **1013**.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed is:

**1.** A method of managing a large-scale information space, comprising the steps of:

populating a digital repository with entries corresponding to nodes of an ontological hierarchy of the large-scale information space, said entries including an identification indicator, and at least one of an ontological hierarchy position indicator for the node and a location indicator of informational content available on a network and corresponding to the ontological hierarchy position;

creating a library user group associating at least one library user with a predetermined category based on a library user identification indicator;

creating a specialized view into the large-scale information space containing a subset of the ontological hierarchy that corresponds to the predetermined category; and

presenting the specialized view into the large-scale information space to a selected one of the at least one library user belonging to the library user group based on the library user identification indicator received from the selected one of the at least one library user that associates the selected one of the at least one library user to the library user group.

**2.** The method of claim **1**, wherein:

at least a portion of the network is an Internet protocol network.

**3.** The method of claim **1**, wherein:

at least a portion of the network is the Internet.

**4.** The method of claim **3**, wherein:

the location indicator comprises a hyperlink to an Internet address containing the informational content.

**5.** The method of claim **1**, wherein:

the large-scale information space is a clinical digital library.

**6.** The method of claim **1**, wherein:

the digital repository comprises a database.

**7.** The method of claim **1**, wherein:

the digital repository comprises a link base.

**8.** The method of claim **1**, wherein:

the specialized view comprises a hierarchy of specialized views.

**9.** The method of claim **1**, further comprising the step of:

recording in the digital repository an entry indicating each node of the ontological hierarchy visited by a library user and at least one of an identification of the library user and a time the node was visited.

**10.** The method of claim **1**, further comprising the steps of:

accessing a resource of informational content corresponding to a particular position of the ontological hierarchy; recording in the digital repository an entry indicating a qualitative feedback from a user of the resource; and



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- adjusting the specialized view so as to privilege the resource based on the qualitative feedback.
- 11.** The method of claim **10**, wherein:  
the adjusting step comprises manipulating metadata maintained in the digital repository corresponding to the resource.
- 12.** The method of claim **1**, further comprising the step of:  
adding new informational content available on the network to the large-scale information space.
- 13.** The method of claim **12**, wherein:  
the new informational content added in the adding step replaces existing informational content.
- 14.** A computer implemented system for managing a large-scale information space comprising:  
a digital repository populated with entries defining nodes of an ontological hierarchy of the large-scale information space, said entries each being associated with an individual node of the ontological hierarchy and having;  
an identification indicator; and  
at least one of an ontological hierarchy position indicator for the node and a location indicator of informational content available on a network and corresponding to the ontological hierarchy position;  
a processor; and  
a computer readable medium encoded with processor readable instructions that when executed by the processor implement,  
a library user group creating mechanism configured to associate at least one library user with a predetermined category based on a library user identification indicator;  
a user view specialization mechanism configured to create a specialized view into the large-scale information space containing a subset of the ontological hierarchy that corresponds to the predetermined category; and  
an ontology traversal mechanism configured to present the specialized view into the large-scale information space to a selected one of the at least one library user belonging to the library user group based on the library user identification indicator received from the selected one of the at least one library user that associates the selected one of the at least one library user to the library user group and allow the selected one of the at least one library user to traverse the ontological hierarchy and informational content identified by the location indicator.
- 15.** The system of claim **14**, wherein:  
at least a portion of the network is an Internet protocol network.
- 16.** The system of claim **14**, wherein:  
at least a portion of the network is the Internet.
- 17.** The system of claim **16**, wherein:  
the location indicator comprises a hyperlink to an Internet address containing the informational content.
- 18.** The system of claim **14**, wherein:  
the large-scale information space is a clinical digital library.
- 19.** The system of claim **14**, wherein:  
the digital repository comprises a database.
- 20.** The system of claim **14**, wherein:  
the digital repository comprises a link base.
- 21.** The system of claim **14**, wherein:  
the user view specialization mechanism is further configured to create a hierarchy of specialized views of the ontological hierarchy.

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- 22.** The system of claim **14**, wherein:  
the computer readable medium is further encoded with processor readable instructions that when executed by the processor further implements;  
a content management mechanism configured to add informational content available on the network to the large-scale information space.
- 23.** The system of claim **22**, wherein:  
the content management mechanism is further configured to replace existing informational content with new informational content.
- 24.** The system of claim **14**, wherein:  
the computer readable medium is further encoded with processor readable instructions that when executed by the processor further implements;  
an exactly-correct server log mechanism configured to maintain a log in the digital repository, said log containing information describing an exact traversal path of the selected one of the at least one library user through the ontological hierarchy including the node visited, and at least one of an identification of the selected one of the at least one library user, a time the node was visited, and a first external location linked to corresponding to informational content visited.
- 25.** The system of claim **24**, wherein:  
the exactly correct server log mechanism is further configured to maintain in the digital repository information indicating a qualitative feedback from a user of a resource accessed by linking to informational content corresponding to a node of the ontological hierarchy.
- 26.** A computer program product, comprising:  
a computer storage medium and a computer program code mechanism embedded in the computer storage medium for causing a processor to manage a large-scale information space, the computer program code mechanism having;  
a first computer code device configured to populate a database with entries defining nodes of an ontological hierarchy of the large-scale information space, said entries each being associated with an individual node of the ontological hierarchy and having;  
an identification indicator; and  
at least one of an ontological hierarchy position indicator for the node and a location indicator of informational content available on a network and corresponding to the ontological hierarchy position;  
a second computer code device configured to create a library user group by associating at least one library user with a predetermined category based on a library user identification indicator;  
a third computer code device configured to create a specialized view into the large-scale information space containing a subset of the ontological hierarchy that corresponds to the predetermined category; and  
a fourth computer code device configured to present the specialized view into the large-scale information space to a selected one of the at least one library user belonging to the library user group based on the library user identification indicator received from the selected one of the at least one library user that associates the selected one of the at least one library user to the library user group and allow the selected one of the at least one library user to traverse the ontological hierarchy and informational content identified by the location indicator.



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27. The computer program product of claim 26, wherein at least a portion of the network is an Internet protocol network.

28. The computer program product of claim 26, wherein: at least a portion of the network is the Internet.

29. The computer program product of claim 28, wherein: the third computer code device is further configured to traverse the informational content by hyperlinking to the Internet address of informational content identified by the location indicator.

30. The computer program product of claim 26, wherein: the specialized view created by the second computer code device comprises a hierarchy of specialized views.

31. The computer program product of claim 26, further comprising:

a fifth computer code device configured to maintain an exactly-correct log in the digital repository, said log containing information describing an exact traversal path of the selected one of the at least one library user through the ontological hierarchy including the node visited, and at least one of an identification of the selected one of the at least one library user, a time the node was visited, and a first external location linked to corresponding to informational content visited.

32. The computer program product of claim 31, wherein: the fourth computer code device is further configured to maintain in the digital repository information indicating a qualitative feedback from a user of a resource accessed by linking to informational content corresponding to a node of the ontological hierarchy.

33. The computer program product of claim 26, further comprising:

a fourth computer code device configured to add informational content available on the network to the large-scale information space.

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34. The computer program product of claim 26, wherein: the fourth computer code device is further configured to replace existing informational content with new informational content.

35. The computer program product of claim 26, wherein: at least a portion of said computer program code mechanism is configured to be invoked through an application program interface.

36. A system for managing a large-scale information space, comprising:

means for populating a digital repository with entries corresponding to nodes of an ontological hierarchy of the large-scale information space, said entries including an identification indicator, and at least one of an ontological hierarchy position indicator for the node and a location indicator of informational content available on a network and corresponding to the ontological hierarchy position;

means for creating a library user group associating at least one library user with a predetermined category based on a library user identification indicator;

means for creating a specialized view into the large-scale information space containing a subset of the ontological hierarchy that corresponds to the predetermined category; and

means for presenting the specialized view into the large-scale information space to a selected one of the at least one library user belonging to the library user group based on the library user identification indicator received from the selected one of the at least one library user that associates the selected one of the at least one library user to the library user group.

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